

great in comparison with the radius of the shell), the wave-length will be approximately 3 kilometres.¹ Increase the frequency now to 1000 periods per second : at distances of hundreds of metres the wave-length will be about 3 metres. Increase now the frequency to 10^6 periods per second ; the wave-length will be 3 millim., and this not only at distances of several times the radius of the shell, but throughout the elastic medium from close to the outer surface of the shell ; because the wave-length now is a small fraction of the radius of the shell. Increase the frequency further to 1000×10^6 periods per second ; the wave-length will be 3×10^{-3} of a millim., or 3 mikroms,² if, as in all probability is the case, the distance between the centres of contiguous molecules in glass and in iron is less than a five-hundredth of a mikrom. But it is probable that the distance between centres of contiguous molecules in glass and in iron is greater than 10^{-5} of a mikrom, and therefore it is probable that neither of these solids can transmit waves of distortional motion of their own ponderable matter, of so short a wave-length as 10^{-5} of a mikrom. Hence it is probable that if we increase the frequency of the rotational vibrations of our shell to one hundred thousand times 1000×10^6 , that is to say, to 100×10^{12} , no distortional wave of motion of the ponderable matter can be transmitted outwards ; but it seems quite certain that distortional waves of radiant heat in aether will be produced close to the boundary of the vibrating shell, although it is also probable that if the surrounding solid is either glass or iron, these waves will not be transmitted far outwards, but will be absorbed, that is to say, converted into non-undulatory thermal motions, within a few mikroms of their origin.

Lastly, suppose the elastic solid around our oscillating shell to be a concentric spherical shell of homogeneous glass of a few centimetres, or a few metres, thickness and of refractive index 1.5 for D light. Let the frequency of the oscillations be increased to 5.092×10^{14} periods per second, or its period reduced to .589212 of a micron : homogeneous yellow light of period equal to the mean of the periods of the two sodium lines will be propagated outwards through the glass with wave-length of about $\frac{2}{3} \times .589212$ of a mikrom, and out from the glass into air with wave-length of .589212 of a mikrom. The light will be of maximum intensity in the equatorial plane and zero in either direction along the axis, and its plane of polarisation will be everywhere the meridional plane. It is interesting to remark that the axis of rotation of the aether for this case coincides everywhere with the line of vibration of the aether in the case first considered ; that is to say, in the case in which the shell vibrated to and fro in a straight line, instead of, as in the second case, rotating through an infinitesimal angle round the same line.

A full mathematical investigation of the motion of the elastic medium at all distances from the originating shell,

¹ "Math. and Phys. Papers," vol. iii. art. civ. p. 522.

² For a small unit of length Langley, fourteen years ago, used with great advantage and convenience the word "mikron" to denote the millionth of a metre. The letter μ has no place in the metrical system, and I venture to suggest a change of spelling to "mikrom" for the millionth of a metre, after the analogy of the English usage for millionths (mikrohm, mikro-ampere, mikrovolt). For a conveniently small corresponding unit of time I further venture to suggest "micron" to denote the period of vibration of light whose wave-length in aether is 1 mikrom. Thus, the velocity of light in aether being 3×10^8 metres per second, the micron is $\frac{1}{3} \times 10^{-14}$ of a second, and the velocity of light is 1 mikrom of space per micron of time. Thus the frequency of the highest ultra-violet light investigated by Schumann (1 of a mikrom wave-length, *Sitzungsber. d. k. Gesellsch. d. Wissensch. zu Wien*, cii. pp. 415 and 625, 1893) is 10 periods per micron of time. The period of sodium light (mean of lines D) is .589212 of a micron ; the periods of the "Reststrahlen" of rocksalt and sylvan found by Rubens and Aschkinass (*Wied. Ann.*, lxx. (1898), p. 241) are 51.2 and 61.1 microns respectively.

No practical inconvenience can ever arise from any possible confusion, or momentary forgetfulness, in respect to the similarity of sound between microns of time and mikroms of space.—K.

for each of the cases of I. (1) and I. (2), will be found in a volume containing my Baltimore Lectures on "Molecular Dynamics and the Wave-Theory of Light," soon, I hope, to be published.

II. An electrical analogy for I. (1) is presented by substituting for our massless shell an ideally rigid, infinitely massive shell of glass or other non-conductor of electricity, and for our massive platinum nucleus a massless non-conducting globe electrified with a given quantity of electricity. For simplicity we shall suppose our apparatus to be surrounded by air or aether. Vibrations to and fro in a straight line are to be maintained by force between shell and nucleus as in I. (1). Or, consider simply a fixed solid non-conducting globe coated with two circular caps of metal, leaving an equatorial non-conducting zone between them, and let thin wires from a distant alternate-current dynamo, or electrostatic inductor, give periodically varying opposite electrifications to the two caps. For moderate frequencies we have a periodic variation of electrostatic force in the air or aether surrounding the apparatus, which we can readily follow in imagination, and can measure by proper electrostatic measuring apparatus. Its phase, with moderate frequencies, is very exactly the same as that of the electric vibrator. Now suppose the frequency of the vibrator to be raised to several hundred million million periods per second. We shall have polarised light proceeding as if from an ideal point-source at the centre of the vibrator and answering fully to the description of I. (1). Does the phase of variation of the electrostatic force in the axial line outside the apparatus remain exactly the same as that of the vibrator? An affirmative answer to this question would mean that the velocity of propagation of electrostatic force is infinite. A negative answer would mean that there is a finite velocity of propagation for electrostatic force. This velocity, according to views regarding conceivable qualities of aether described in my article "On the Reflection and Refraction of Light" (*Phil. Mag.*, vol. xxvi. 1888) might be greater than, equal to, or less than the velocity of light.

III. The shell and interior electrified non-conducting massless globe being the same as in II., let now a forcive be applied between shell and nucleus to produce rotational oscillations as in I. (2). When the frequency of the oscillations is moderate, there will be no alteration of the electrostatic force and no perceptible magnetic force in the air or aether around our apparatus. Let now the frequency be raised to several hundred million million periods per second ; we shall have visible polarised light proceeding as if from an ideal point-source at the centre and answering fully to the description of the light of I. (2). The same result would be obtained by taking simply a fixed solid non-conducting globe and laying on wire on its surface approximately along the circumferences of equidistant circles of latitude, and, by the use of a distant source (as in II.) sending an alternate current through this wire. In this case, while there is no manifestation of electrostatic force, there is strong alternating magnetic force, which in the space outside the globe is as if from an ideal infinitesimal magnet with alternating magnetisation, placed at the centre of the globe and with its magnetic axis in our axial line.

THE SERUM TREATMENT OF RINDERPEST.

THE Report of the Colonial Veterinary Surgeon and the Assistant Veterinary Surgeons of the Cape of Good Hope is at the present time a document of very considerable interest, as it is possible from the facts there set forth to form some definite opinion as to the efficacy of the various methods of protection and treatment against rinderpest that have been recommended in the Colony. It appears that there is now a possibility of completely eradicating rinderpest from South Africa, not,

however, by means of the bile method—which was originally introduced by Koch, and appears to induce only a temporary though “active” immunity against the disease—but by means of the use of a “serum.”

Drs. Turner and Kollé have, as already reported in these columns, found that it is possible to treat rinderpest successfully with a serum taken from animals which have already suffered from the disease produced either artificially or naturally and reinforced artificially. As a result of their investigations they are now in a position, with the aid of this serum, to control the course of the disease when artificially produced. As animals which have suffered from the disease are immune for a very considerable period, and as an animal that passes through an attack controlled by the serum is protected or “salted,” as it is termed, this method has been adopted very extensively for the purpose of protecting animals in affected and suspected districts, and it is probable that in time it will oust the bile method completely; especially as it seems to be attended by fewer disadvantages than accompany the latter method, and can be carried out at less cost and with less loss of life amongst the cattle.

In working with the serum method in rinderpest it is necessary to know as much about the serum used as it is in the case of the treatment of diphtheria with anti-diphtheric serum; but one would imagine that at the Cape, where such enormous financial interests are concerned, there should be no difficulty in obtaining pure serum, the value of which has been carefully estimated, for the treatment of cattle suffering from the earlier symptoms of rinderpest. The relative cost would be slight even were it necessary to have a series of stations from which serum might be obtained, and taking into consideration the fact that this serum might have to be thrown away periodically; and one can scarcely imagine that a method which is described as being nearly perfect, should be allowed to remain unused because there is some slight difficulty as regards the supply of money and laboratory accommodation. In connection with this part of the question, it may be mentioned that it has been proved by experiment that the serum remains quite active for at least seven months. How much longer, still remains to be proved.

It will be remembered that on a former occasion it was pointed out that “it is useless to attempt to infect whole herds which have been previously inoculated with bile, because it does not seem possible to give all such inoculated animals the disease simultaneously. Most of the cattle will become sick after injection of virulent blood, but many may remain unaffected, as the immunity conferred by the bile is still effective and protects them, and they will in consequence not become salted. In these herds the most satisfactory course to pursue is for the owner to obtain a sufficient supply of serum, and inject the cattle as soon as they are observed to be sick, or the thermometer indicates a rise of temperature. Cattle already sick require a larger dose of serum than those that are healthy, and in severe cases a second may be necessary.” This, however, as pointed out by the Veterinary Surgeon, is only an indication that the serum must be injected at a still earlier stage than has hitherto been done, so that it is necessary to apply the serum treatment to a herd of cattle which has previously been inoculated with bile soon after the injection of the virulent blood. Cattle that would have reacted to the blood take the disease in a modified form, and become salted; whilst those that would not react are no worse off for the addition of the serum, and probably have a slight addition to their passive immunity. The principal Veterinary Surgeon points out that “the fact that the immunity conferred by bile is now wearing off, makes it necessary for the farmers to take prompt action when the disease appears in their herds, and the fact that the bile immunity has ceased, gives greater

prospects of success attending the application of the serum as above indicated.” He also points out that infection is not nearly so frequently carried from artificially infected herds as from those which take the disease naturally.

Bearing on this question, there is an interesting article in the August number of the *Agricultural Journal and Mining Record*, published in Natal. The injection of bile, unless very carefully selected and preserved, appears in many cases to have set up chronic abscesses, from the description of which one would have said that they were actinomycotic or discomycotic in character, though this is a question which appears to deserve further investigation. From the annual report of the Commissioner of Agriculture for the year 1897, which appears in the same journal, it is evident that the farmers are now thoroughly alive to the importance of using bile where serum cannot be obtained, but of having recourse to serum inoculation along with the injection of blood from diseased animals, when this method can be properly carried out. The only real drawback, and this is a very slight one indeed, appears to be that in a few cases the injected blood appears to set up some form of “red water,” whilst in a few instances a malarial parasite may be transmitted along with the blood.

An idea of the expenditure on rinderpest for the year 1897 may be gathered from the fact that the outlay for fences, &c., was nearly 170,000*l.* A very small proportion of this, added to the laboratory and veterinary outlay, would enable the department to cope with this disease in future, and to save the Colony an enormous sum, both directly and indirectly. Mr. Watkins Pitchford, in his report, states that where the departmental instructions for the use of the serum have been adhered to, good “and often brilliant results have repeatedly been achieved,” and that he is right in his conjecture is very evident from the fact that when the serum is given in definite quantity on one side and rinderpest blood on the other, but simultaneously, a reaction is invariably set up in an unsalted animal; and even when this reaction is not very severe, the nature of the disease is so well defined and the results so successful that the animal is perfectly salted for some time against natural infection, and frequently against the injection of rinderpest blood: the severest test to which the method can be put. He believes thoroughly in the permanent immunisation of the herds as a means of stamping out rinderpest; but immunisation with bile, he believes, would fail, although it may be useful as a temporary measure where serum cannot be obtained. It must be remembered, however, that the immunisation of the first animal must as a rule be through the use of bile. He is strongly in favour of maintaining a trustworthy supply of serum for the cases as they may appear, and for the immunisation of any stock in herds which have already passed through the disease, but in which the immunity is still not quite sufficient. Those who are most intimately acquainted with the history of rinderpest, and of the recent work on serum-therapy in connection with this disease, are now satisfied that the extinction of rinderpest amongst Cape cattle is already practically accomplished.

NOTES.

ON Friday last, November 11, the Chemical Society gave a banquet in honour of six of its Past-Presidents who had been for over half a century Fellows of the Society. The occasion was the more noteworthy that these eminent chemists—Gilbert, Frankland, Odling, Abel, Williamson, and Gladstone—are in many cases ranked among those whose teaching has most deeply influenced chemical science. As M. Friedel said: “They form the finest phalanx of the fathers of chemistry